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Fifteenth day of April 2004

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WATER RECOVERY SYSTEMS AND CONTROL VALVES

This invention relates to water recovery systems and control valve for water recovery systems. The invention has particular application to the recovery of water from the hot water pipe downstream of a household hot water storage tank after it has cooled.

A well known problem with household hot water reticulation systems is that the water which stays in the pipe between the hot water storage tank and the shower head while the shower tap is turned off loses its heat and then is wasted by the next person using the shower. Other household facilities such as washbasins and sinks suffer from the same waste problem.

A number of attempts have been made at overcoming the abovementioned problem of water wastage. For example, United States patent No.5105846 to Britt describes a recovery system in which the cooled water downstream of the hot water tank is diverted to a small pump which pumps the diverted water into the cold water pipe from where it flows back into the hot water system to be reheated or to any other cold water tap which is turned on. The system uses a timer to set the period of time for which the pump runs or the pump can be manually switched on and off as desired by a user. The Britt system suffers from a number of problems, one being that it relies on the user switching the pump on and running it for a suitable period to purge only the

cooled water in the pipe. Another is that the user has no indication that the water in the pipe has cooled too much to be used as hot water.

United States patent No.4697614 to Powers describes another recovery system in which the cooled water is diverted from the hot water pipe just upstream of a hot water outlet tap to an accumulator tank by a manually actuated electrical flow control valve. The accumulator has a spring loaded diaphragm which forces the accumulated water into the cold water pipe when the cold water tap is turned on. The Powers system also suffers from a number of problems, one being that the accumulator needs to be housed in close proximity to the hot water outlet tap which is not always possible in existing homes due to its size. Additionally, the powers system requires the installation of a power switch to operate the flow control valve.

The present invention is aimed at overcoming or at least ameliorating at least one of the aforementioned problems with known water recovery systems. Another object is to provide a water recovery system which can be installed relatively easily either during construction of a house or other building or as a retrofit.

With the foregoing in view, the invention in one aspect resides broadly in a water recovery system adapted to be fitted to a water reticulation system of a building, the reticulation system including a hot water storage tank, a cold water supply

pipe connected to one or more cold water outlet taps and the inlet of the hot water storage tank, and one or more hot water delivery pipes connected to the outlet of the hot water storage tank, the recovery system being adapted to recover cold water from the hot water delivery pipe between the hot water storage tank and at least one of the hot water outlet taps and including:

cold water storage means adapted to store cold water;

a diverter valve in the hot water delivery pipe adapted to selectively divert water from the hot water delivery pipe to said cold water storage means upon said at least one hot water outlet tap being turned on;

a venturi type suction device in the cold water supply pipe upstream of the hot water storage tank having an inlet connected to said cold water storage means, said venturi being adapted to draw water into the cold water supply pipe from said cold water storage means during flow of water through the cold water supply pipe.

In another aspect the invention resides broadly in a valve assembly including:

a housing having a water supply inlet adapted to be connected to a hot water delivery pipe downstream from a hot water storage tank, a hot water outlet adapted to be connected to a hot water outlet tap, and a cold water outlet adapted to be connected to a cold water storage tank;

a hot water flow passage between said water supply inlet and

said hot water outlet and a cold water flow passage between said water supply inlet and said cold water outlet;

hot water valve means adapted to open said hot water flow passage in response to entry of hot water into said housing through said water supply inlet and to close said hot water flow passage in response to entry of cold water into said housing through said water supply inlet;

first cold water valve means adapted to open said cold water flow passage at a first position in response to entry of cold water into said housing through said water supply inlet and to close said cold water flow passage at said first position in response to entry of hot water into said housing through said water supply inlet;

second cold water valve means in series with said first cold water valve means adapted to open said cold water flow passage at a second position in response to a predetermined drop in pressure at said hot water outlet and to close said cold water flow passage at said second position in response to a predetermined increase in pressure at said hot water outlet.

In another aspect the invention resides broadly in a valve assembly including:

a housing having a water supply inlet adapted to be connected to a hot water delivery pipe downstream from a hot water storage tank, a hot water outlet adapted to be connected to a hot water outlet tap, and a cold water outlet adapted to be

connected to a cold water storage tank;

a hot water flow passage between said water supply inlet and said hot water outlet and a cold water flow passage between said water supply inlet and said cold water outlet;

hot water valve means adapted to open said hot water flow passage in response to entry of hot water into said housing through said water supply inlet and to close said hot water flow passage in response to entry of cold water into said housing through said water supply inlet or water in said housing cooling to a predetermined temperature;

first and second cold water valve means adapted to open said cold water flow passage in response to entry of cold water into said housing through said water supply inlet or water in said housing cooling to a predetermined temperature and a predetermined drop in pressure at said hot water outlet and to close said cold water flow passage in response to entry of hot water into said housing through said water supply inlet and a predetermined increase in pressure at said hot water outlet.

Advantageously, the valve assembly does not require any electrical input in order to operate thus allowing for easy and inexpensive installation.

Preferably, the hot water valve means and the first cold water valve means include a shared actuator which is adapted to simultaneously open the hot water flow passage and close the cold water passage and vice versa. In such form it is preferred that

the actuator be in the path of water entering the valve assembly through the hot water inlet and be responsive to the temperature of the incoming water. It is also preferred that the actuator be mounted in an inlet chamber which forms part of the hot water flow passage when water is flowing from the hot water inlet to the hot water outlet and part of the cold water flow passage when water is flowing from the hot water inlet to the cold water outlet. Advantageously, such arrangement provides for rapid change of the hot water valve means so as to close the cold water passage and open the hot water passage upon entry of hot water into the inlet chamber, thereby not diverting hot water to the cold water outlet unnecessarily.

Preferably, the second cold water valve means includes a second actuator which is in fluid communication with the hot water outlet so as to allow the water pressure at the hot water outlet to cause the actuator to move a valve member to close the cold water flow passage. In a preferred form the actuator is a diaphragm which is connected to a valve member and adapted to force it into engagement with a valve seat defining an opening in the cold water flow passage to thereby close the passage. In such form, biassing means are provided to bias the diaphragm into the engaged position. In one such form of the invention a bleed passage is provided to bypass the hot water flow passage to allow constant fluid communication between the hot water inlet and the hot water outlet thereby maintaining them at the same pressure

while the hot water tap is closed and the cold water flow passage is open at the first cold water valve means. Advantageously, because the diaphragm is also in fluid communication with the hot water outlet, the bleed passage also causes the diaphragm to hold the valve member in the closed position while the hot water flow passage is closed and the hot water tap are closed.

Suitably, the valve assembly can be used to advantage in the water recovery system previously described. Advantageously, such a diverter valve relies only on water flow for its operation as does the venturi device whereby the system can function efficiently for water recovery without the need for an external power source.

It will be understood that the invention is applicable to hot water reticulation systems which do not have a hot water storage tank, but have other types of hot water systems, for example, instantaneous systems which heat the water on demand as it flows through a heat exchanger. Thus, the term "hot water system" should be understood as encompassing all such hot water systems unless that is not appropriate in the context.

The terms "upper", "lower", "side" are used herein to for the purpose of describe the invention in the position shown in the drawings and are not intended to limit use of the invention to any particular orientation unless the context clearly indicates otherwise.

In order that the invention may be more clearly understood

and put into practical effect, reference will now be made to the accompanying drawings wherein:

Fig. 1 is a schematic diagram of a water recovery system according to the present invention installed in a dwelling house;

Fig. 2 is a pictorial representation of a valve assembly according to the invention;

Fig. 3 is a cross-sectional elevation of the valve assembly of Fig. 2 along line 3-3 in a no flow situation;

Fig. 4 is a cross-sectional elevation of the valve assembly of Fig. 2 along line 3-3 in a hot water flow situation;

Fig. 5 is a cross-sectional end elevation of the valve assembly of Fig. 2 along line 5-5.

Fig. 6 is a diametric cross-sectional elevation of the ceramic plate assembly shown in the valve assembly of Fig. 2;

Fig. 7 is a plan view of the diaphragm valve assembly shown in the valve assembly of Fig. 2; and

Fig. 8 is a cross-sectional elevation of the diaphragm valve assembly of the valve assembly of Fig. 2.

The water recovery system 10 illustrated diagrammatically in Fig. 1 includes a typical hot water system 11 installed in a dwelling house which is connected to hot and cold water mixer 13 at the sink 14 by pipe 12. Mains pressure cold water is supplied to the hot water system by a cold water supply pipe 17 via a

venturi device 15 which will be described later while cold water is supplied to the mixer 13 by the direct cold water supply pipe 16. Other facilities such as shower heads, wash basins, bathtubs and laundries are supplied in the same manner except that the hot and cold water pipes may be connected to hot and cold water taps respectively rather than a mixer and the invention operates in the same manner. Although in this embodiment, water is supplied by city mains at mains pressure, in other embodiments, water is supplied by pressure pumps from a tank supply and in still others, low pressure gravity supply systems are used.

A diverter valve assembly 18 of the type illustrated in Fig. 2 is installed in the hot water supply pipe 12 in close proximity to the mixer 13. The diverter valve is arranged to divert cooled water in the hot water supply pipe to a storage tank 19 via the cooled water diversion pipe 21 which is connected to storage tank inlet 22. However, in other embodiments, the diverted water could be directed to an irrigation facility, a stock trough or some other facility. The tank has a discharge outlet 23 which is connected to the venturi device via a cooled water supply pipe 26. the venturi device has a main supply inlet 31, a main outlet 32 and a suction inlet 33 to which the cooled water pipe 26 is connected. As mains pressure water flows through the venturi device from the main inlet to the main outlet, it "sucks in" water from the storage tank. A low water and non-return valve 27 is provided in the cooled water supply pipe 26 to prevent air

being sucked into the hot water system when the storage tank is empty and to prevent back flow of water from the mains into the storage tank. A hot water system bypass pipe 36 is connected between the cold water supply pipe 14 and the hot water discharge pipe 12 via a thermostatic mixing valve 37.

As can be seen in Fig. 3, the diverter valve assembly 18 has a cylindrical housing 41 made up of upper and lower cylindrical housing halves 42 and 43 respectively having complementary cylindrical walls 42a and 43a which are screwed together to form screwed joint 44, and opposed spaced apart end walls 42b and 43b. The lower half also has a divider wall 46 extending inwardly from the end wall to form two separate compartments in fluid communication via a flow passage 47 through the divider wall. A hot water inlet opening 48 is provided in the cylindrical wall of the upper housing half while a hot water outlet opening 49 and a cooled water outlet opening 50 are provided in the cylindrical wall of the lower housing half. Other types of valve assemblies could be used if desired, for example, instead of dovetail plates as shown, a tube system could be used.

A ceramic valve assembly 51 comprising a fixed ceramic plate 52 and a movable ceramic plate 53 is fitted in the housing with the fixed ceramic plate resting on a shoulder 54 provided in the lower housing half adjacent the screw threaded free end of the cylindrical wall 43a. The free end of the upper cylindrical wall engages with the fixed ceramic plate to secure the ceramic plate

assembly in position when the two housing halves are screwed together.

As can be seen in Fig. 3, the ceramic plate assembly together with the upper housing half defines a hot water inlet chamber 56 which can receive hot water from the hot water supply pipe 12 through the hot water inlet opening 48. Similarly, the ceramic plate assembly together with the lower housing half defines a hot water discharge chamber 61 on one side of the divider wall 46 which can discharge water through the discharge opening 49, and a cooled water discharge chamber 63 on the other side of the divider wall which can discharge cooled water through the cooled water discharge opening 50.

The ceramic plate assembly has two sets of openings which are adapted to selectively create a hot water flow passage 64 from the hot water inlet chamber 56 to the hot water discharge chamber 61 or a cooled water flow passage 65 from the hot water inlet chamber to the cooled water discharge chamber. For this purpose the movable ceramic plate has three openings 66 therein towards one end which are adapted to selectively align with three complementary openings 67 in the fixed ceramic plate as shown in Fig. 4.

Similarly, three openings 68 are provided in the movable ceramic plate towards its other end which are adapted to selectively align with three complementary openings 69 in the fixed ceramic plate as shown in Fig. 3. It can be seen that the

two ceramic plates are arranged such that when the openings 66 are aligned with openings 67 to create flow passage 64 into the hot water discharge chamber, the openings 68 are out of alignment with opening 69 so that water cannot pass from inlet chamber 56 to cooled water discharge chamber 63. When the movable ceramic plate is slid the other way the cooled water flow passage is created and the hot water flow passage is closed.

An additional opening 71 through the fixed ceramic plate is also provided for the purpose of maintaining fluid communication between the hot water inlet chamber 56 and the hot water discharge chamber 61 when the passage 64 is closed in order to equalise the pressures in those two chambers.

Movement of the movable ceramic plate relative to the fixed ceramic plate is achieved by a thermostatic linear actuator 73. The actuator has a wax-filled cylinder 74 with a piston 75 slidably mounted therein for movement relative thereto from a retracted position to an extended position with the cylinder secured to the housing wall 42a and the piston secured to the movable ceramic plate. The thermostatic actuator is configured so that when the water in chamber 56 is below a predetermined "cool" temperature, the piston is in the retracted position and the openings 68 and 69 are aligned to create the cooled water flow passage 65 mentioned earlier and when the temperature of the water in the hot water inlet chamber 56 reaches a predetermined "hot" temperature, the piston is in the extended position and the

openings 66 and 67 are aligned to create the hot water flow passage 64 mentioned earlier while the cooled water flow passage is closed. A spring 76 which is positioned between the piston and the wall 42a is arranged to bias the piston towards the retracted position so that the hot water flow passage closes as the water in the hot water inlet chamber cools. Other types of actuators could be used to the same effect.

A diaphragm valve assembly 80 is fitted in the cooled water discharge chamber 63 in order to selectively open and close the cooled water flow passage downstream of the ceramic plate assembly thus providing a means of closing that passage in a second position.

The diaphragm valve assembly includes a plate 81 extending across the cooled water discharge chamber 63 with an opening 82 therein providing the only passage between the ceramic plate assembly and the cooled water discharge opening 50. A valve member 83 is arranged to selectively engage with a valve seat around the opening 82 so as to open and close the cooled water flow passage through the opening. The valve member is moved towards the closed position by a diaphragm 84 which also extends across the chamber and is subject to the pressure of water in the hot water discharge chamber 61 via passage 47 and towards the open position by the pressure of cooled water on the valve head. The diaphragm and the attached valve member is biased towards the closed position by a coil spring 86 which is fitted between the

lower housing wall 43b and the diaphragm. The valve head and the diaphragm are selected to achieve the desired movement of the valve member as will be more clearly understood from the following description of the operation of the valve assembly.

In use, when hot water from the hot water system has not been used for some time and the water in the discharge pipe 12 has cooled to the predetermined "cool" temperature, the actuator 74 will be in the position shown in Fig. 3 with the openings 68 and 69 aligned creating the cooled water flow passage 65 into the cooled water discharge chamber 63. The hot water openings 66 and 67 will be out of alignment so that hot water flow passage 64 is closed preventing flow of water to the hot water discharge outlet 49 except for water flowing through the bypass opening 71. When the hot water outlet 13 is turned on the pressure in the hot water discharge chamber 61 will instantaneously drop thereby causing a drop in pressure against the diaphragm 84. As the pressure against the diaphragm drops the cooled water pressure against the valve member 82 will force it downwards to the open position shown in Fig. 4 thereby opening the cooled water flow passage through opening 82 to cooled water discharge opening 50. Cooled water from the hot water discharge pipe 12 will continue to flow into the hot water inlet chamber 56 and then to the cooled water discharge opening until hot water from the hot water system reaches the hot water inlet chamber and causes the actuator piston 75 to move to the extended position thereby

opening the hot water flow passage 64 and coincidentally closing the cooled water flow passage 65.

When the hot water tap is turned off, the pressure in hot water discharge chamber 61 increases instantaneously to equalise with the hot water supply pressure thereby assisting the spring to force the diaphragm to move the valve member 83 to close the opening 82 thereby closing the cooled water flow passage in the second position.

As the water in the hot water inlet chamber 56 gradually cools, the piston 75 will move to the retracted position thereby closing the hot water flow passage 64 and opening the cooled water flow passage 65. However, the valve member 83 remains engaged with the plate 81 to keep opening 82 closed by virtue of the pressure on the diaphragm from the hot water discharge chamber 61 which is equalised with the pressure in the hot water inlet chamber 56 via bypass passage 71.

It will be appreciated that cooled water which is discharged through cooled water discharge outlet 50 accumulates in the storage tank 19 and re-enters the reticulation system through the venturi device 24 when either hot or cold water taps are turned on.

In other embodiments of the invention, the hot water inlet opening and the hot water outlet opening are on the opposed end walls 42b and 43b respectively. In still other embodiments the ceramic plate assembly and linear actuator are replaced by a

ceramic disc assembly and bimetallic coil which is adapted to rotate one disc relative to a fixed disc in order to align complementary openings similar to openings 66 and 67, and 68 and 69.

Advantageously, the water recovery system of the present invention relies only on water flow through the supply pipe to operate the venturi device and a mechanically and thermostatically controlled diverter valve to direct hot water or cooled water to the desired outlet.

While the forgoing description has been given by way of illustrative examples of the invention, it will be understood that the invention may be embodied in many other forms and all such forms are deemed to fall within the broad scope and ambit of the invention as hereinbefore described.

Dated this 2nd Day of April, 2003

ANDREW DONALD WILLSFORD and CHRISTOPHER JAMES MURRAY
By their Patent Attorneys
AHEARN FOX

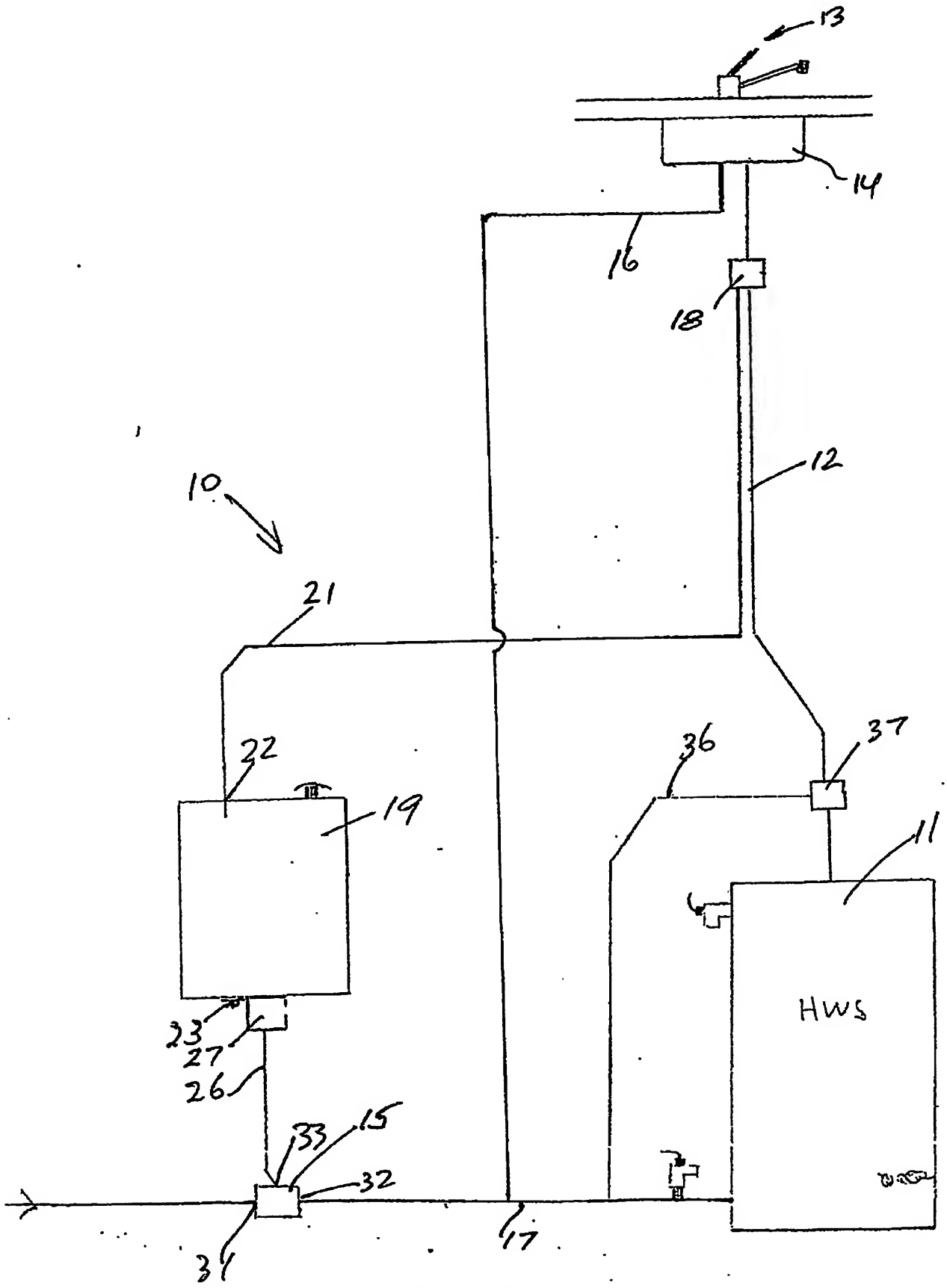
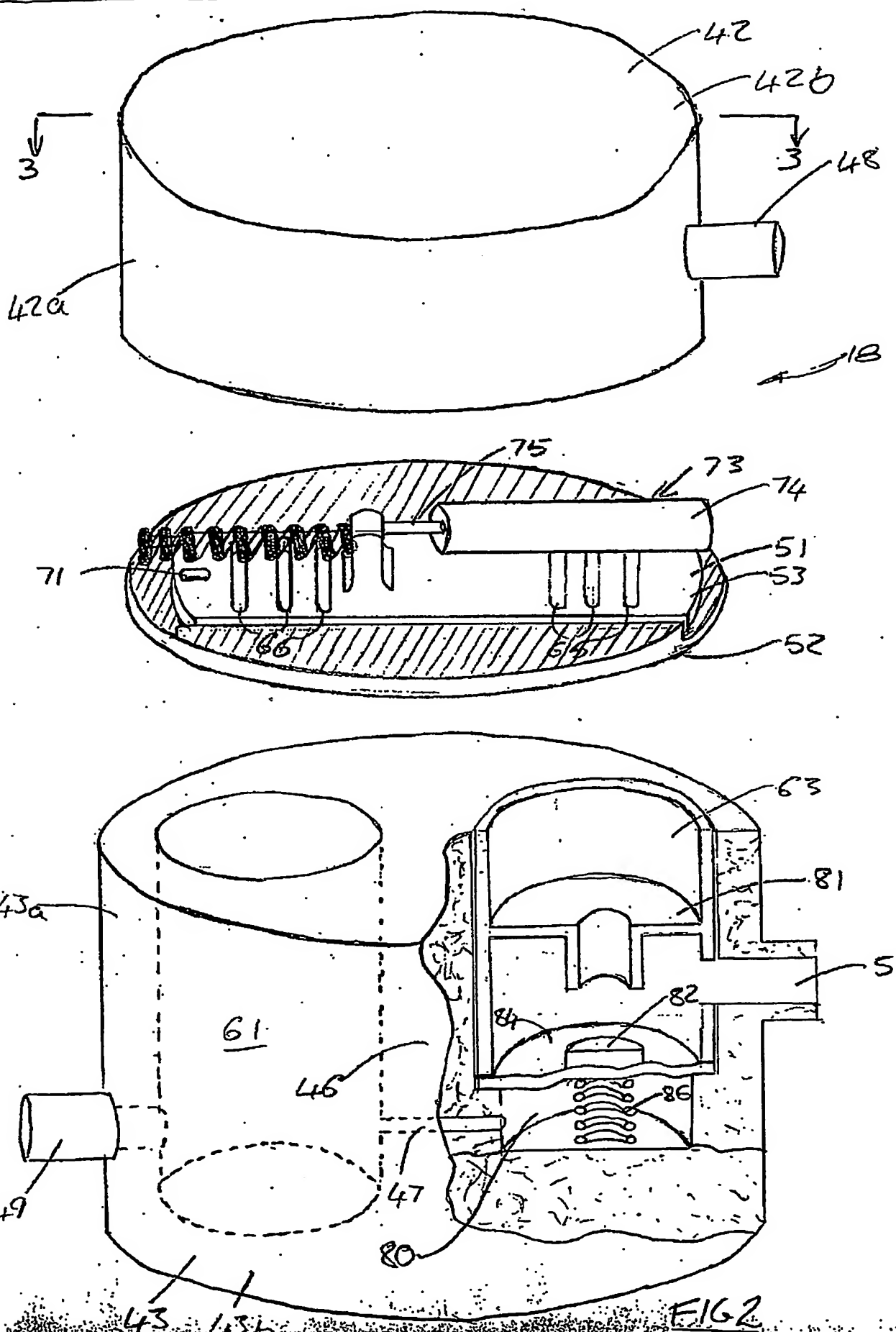


FIG 1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74
71
51
53
66
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50
82
84
61
46
86
49
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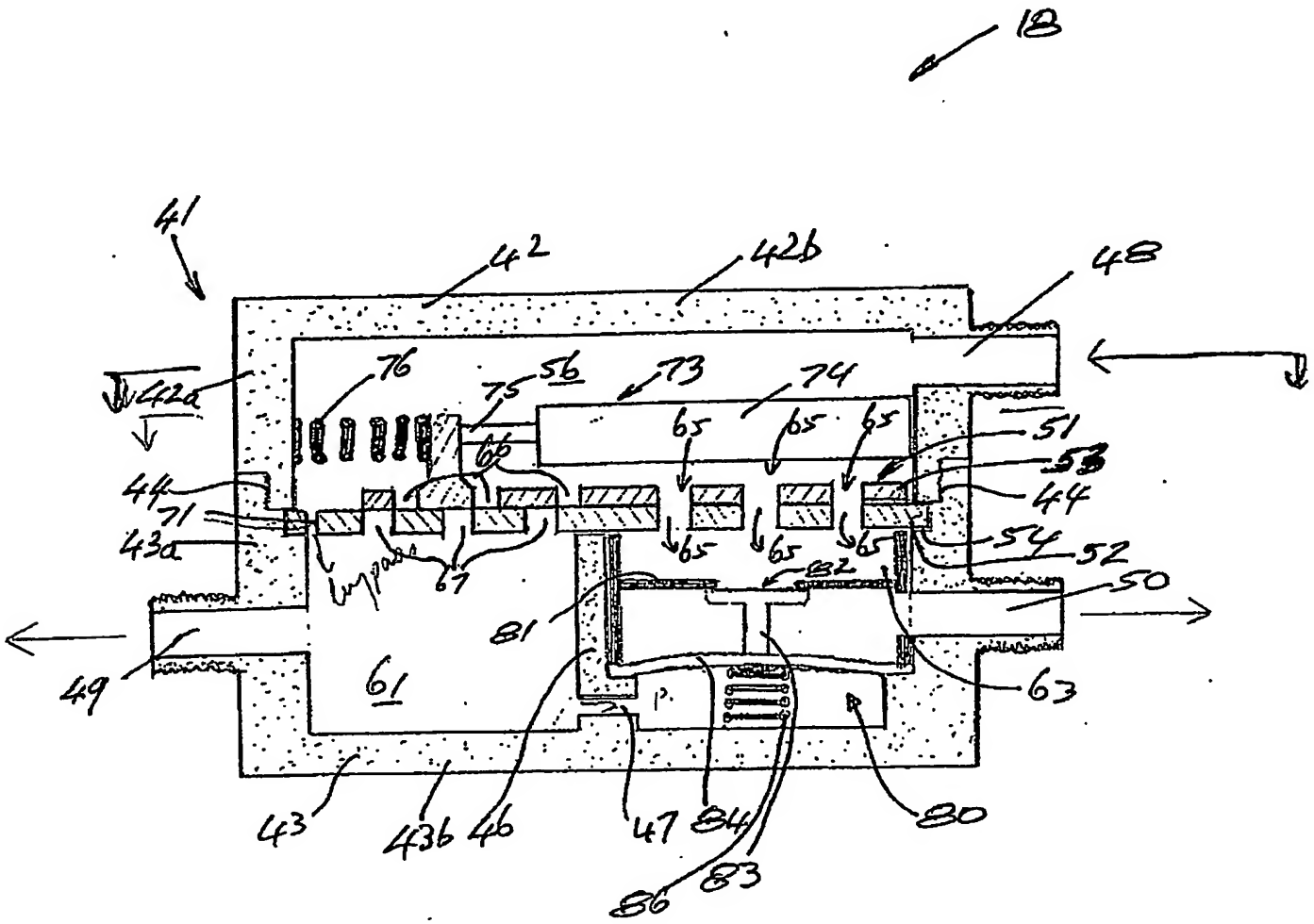
80
43
43b

FIG2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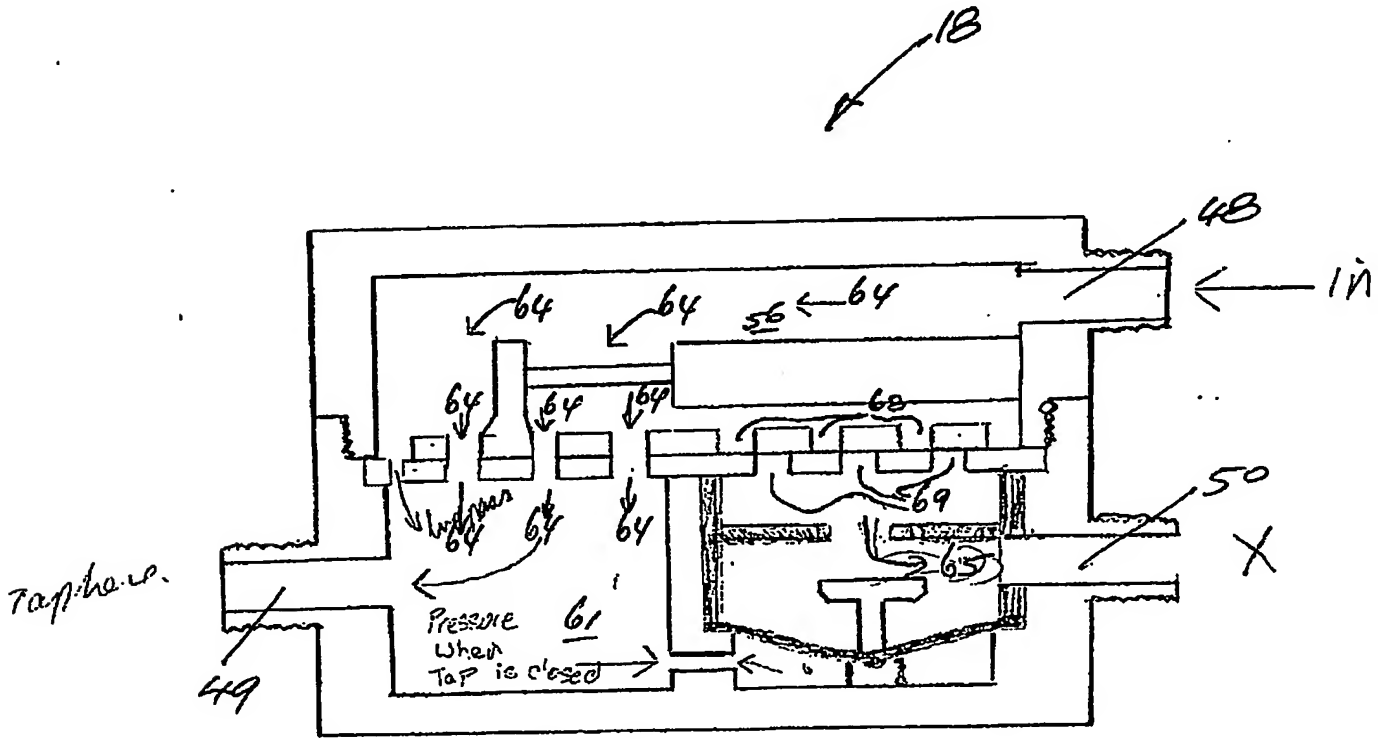
18
48
IN
64
64
56
64
64
64
64
68
69
50
X
65
Tap hose
Pressure 61
When
Tap is closed
49

FIG 4

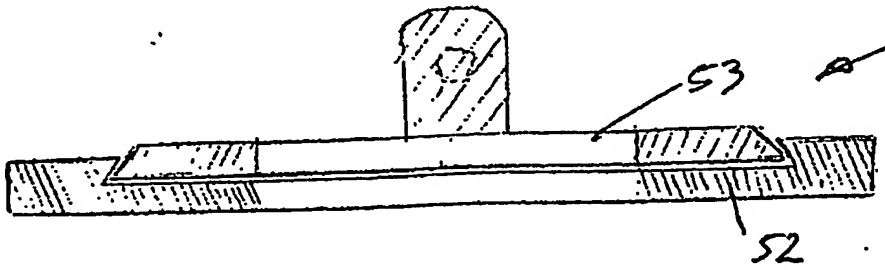

FIG. 6

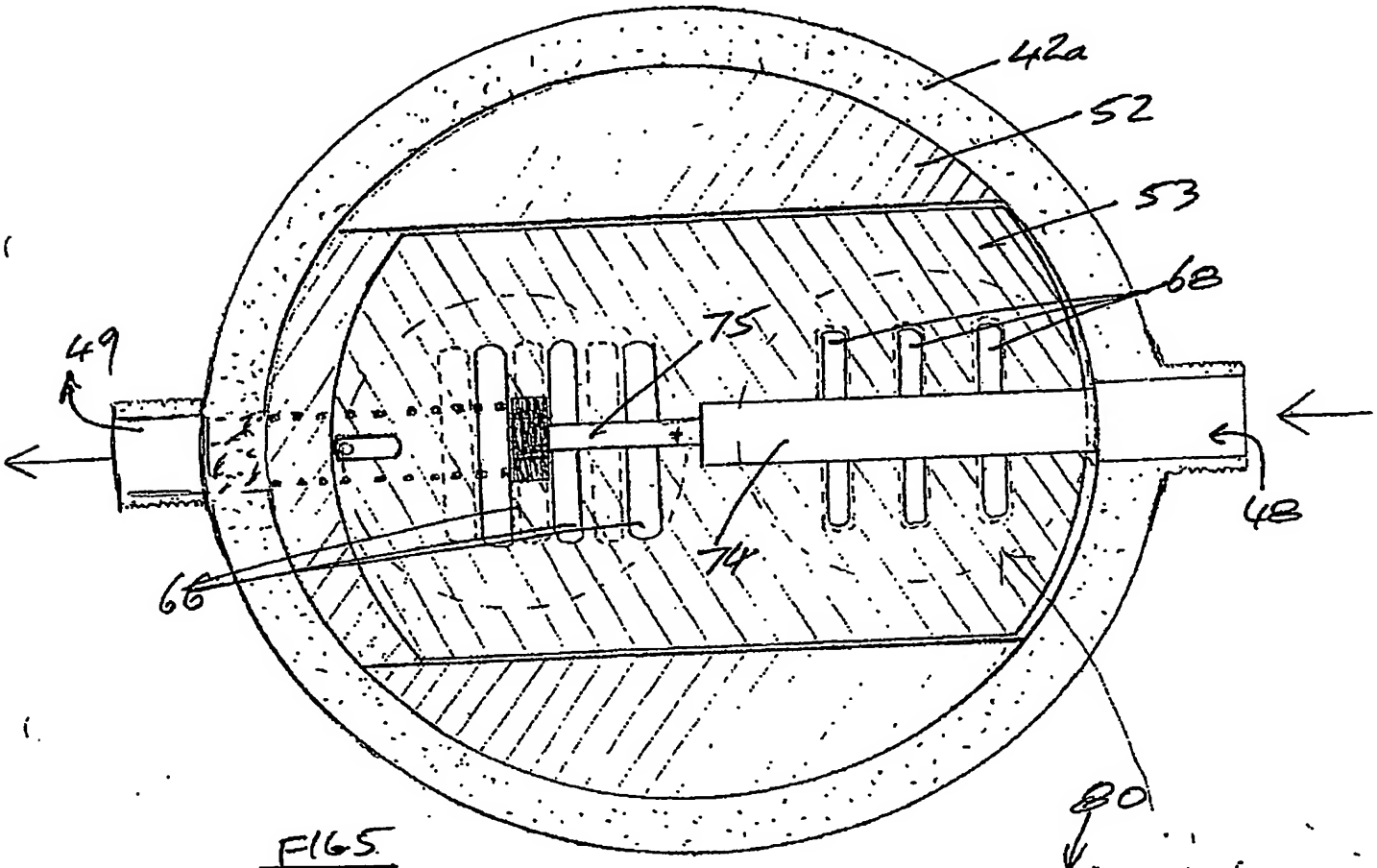

FIG. 5

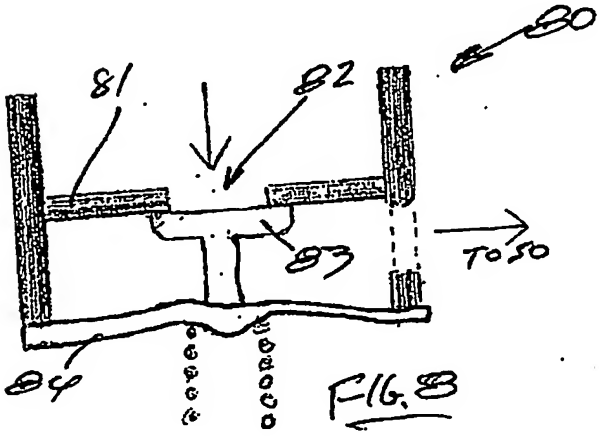

FIG. 8

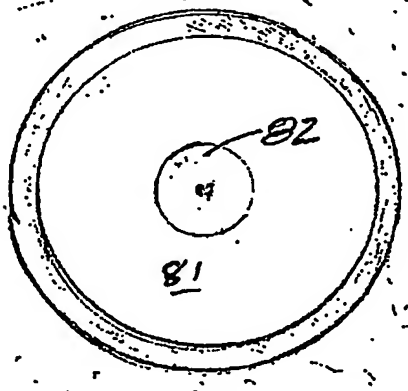

FIG. 7